From Silos to Synergy: AI as a Catalyst for Precision Healthcare in Dentistry and Otorhinolaryngology

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Abstract

Artificial Intelligence (AI) is revolutionizing healthcare by bridging the gap between traditionally siloed disciplines. In dentistry and otorhinolaryngology (ENT), AI enables integrated, patient-centered care through advancements in imaging, digital twins, and clinical decision support systems (CDSS). This article explores AI's transformative role across oncology, temporomandibular joint (TMJ) disorders, sleep apnea, and craniofacial diagnostics, highlighting its impact on precision healthcare. The discussion emphasizes both current applications and future directions, illustrating how AI facilitates more accurate diagnoses, personalized treatments, and enhanced patient outcomes.

Key Words: artificial intelligence; precision healthcare; dentistry; otorhinolaryngology; digital twins

Introduction

Dentistry and ENT have traditionally operated in separate silos, often resulting in fragmented patient care. Recent advancements in Artificial Intelligence (AI) are overcoming these barriers, enabling a unified approach to patient management [1,2]. AI integration into clinical workflows enhances diagnostic accuracy, personalizes treatment plans, and fosters interdisciplinary collaboration, thereby advancing precision healthcare [3].

Clinical Applications of AI in Dentistry and ENT

Oncology

AI-driven imaging analysis, particularly through deep learning algorithms, has significantly improved early detection and staging of head and neck cancers [4,5]. Systems like DXplain assist clinicians in generating stratified diagnoses based on patient data, enhancing diagnostic accuracy and treatment planning [1].

Temporomandibular Joint (TMJ) Disorders

AI applications in TMJ diagnostics include the use of convolutional neural networks (CNNs) to analyze radiographic images, facilitating early detection of joint pathologies [6]. These tools assist clinicians in assessing joint space narrowing and other indicators of TMJ disorders [7].

Sleep Apnea

AI enhances the diagnosis and management of sleep apnea by analyzing polysomnographic data and imaging studies [8]. Machine learning models predict treatment outcomes, aiding in the personalization of therapeutic interventions [9].

Craniofacial Imaging

Advanced imaging techniques, such as Cone Beam Computed Tomography (CBCT), combined with AI algorithms, enable detailed visualization of craniofacial structures [10]. AI assists in identifying anatomical anomalies and planning surgical interventions with greater precision [6].

Advanced Imaging and Digital Twins

Digital twin technology creates virtual replicas of patients' anatomical structures, allowing simulation of surgical procedures and treatment outcomes [11]. In dentistry, digital twins facilitate personalized treatment planning, particularly in orthodontics and implantology [12]. Similarly, in ENT, digital twins assist in preoperative planning and postoperative assessment, improving surgical precision and patient outcomes [13].

Clinical Decision Support Systems (CDSS)

CDSSs integrate AI with electronic health records to provide real-time, evidence-based recommendations [14]. These systems support clinicians in diagnosing complex conditions, selecting appropriate therapies, and monitoring patient progress [15]. In geriatric dentistry, CDSSs enhance therapeutic planning by considering age-related factors and comorbidities [16].

Challenges and Limitations

Despite promising applications, challenges impede the widespread adoption of AI in dentistry and ENT. Issues such as data privacy concerns, the need for standardized data formats, and integration into clinical workflows require attention [17]. Additionally, clinical validation of AI systems is essential to ensure safety and efficacy [18].

Future Directions

The future of AI in dentistry and ENT lies in the development of integrated, multidisciplinary platforms that facilitate seamless data exchange and collaborative decision-making [19]. Advancements in natural language processing and multimodal AI models will further enhance diagnostic capabilities and treatment personalization [20]. Continued research is crucial to fully realize AI's potential in transforming patient care across these specialties [11,12].

Conclusion

AI is a catalyst for transforming fragmented dental and ENT practices into integrated, precision-focused healthcare systems. By leveraging AI in imaging, digital twins, and CDSS, clinicians can achieve more accurate diagnoses, personalized treatments, and improved patient outcomes. Ongoing integration promises to redefine healthcare delivery in dentistry and ENT, moving toward a synergistic, patient-centered model.

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